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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/896,783	06/29/2001	Clyde George Bethea	25-66-105-20-29-1-3-35-14	8896

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Lucent Technologies Inc.
Docket Administrator (Room 3J-219)
101 Crawfords Corner Road
Holmdel, NJ 07733

EXAMINER	
LI, SHI K	

ART UNIT	PAPER NUMBER
2613	

MAIL DATE	DELIVERY MODE
11/16/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)
	09/896,783	BETHEA ET AL.
	Examiner	Art Unit
	Shi K. Li	2613

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 20 August 2007.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-3 and 6-24 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-3 and 6-24 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 1, 6, 8, 10-13 and 15-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Paiella et al. (R. Paiella et al., "Generation and Detection of High-Speed Pulses of Mid-Infrared Radiation with Intersubband Semiconductor Lasers and Detectors", IEEE Transactions on Photonics Technology Letters, Vol. 12, No. 7, July 2000) in view of Christopher (U.S. Patent Application Pub. 2002/0181059 A1), Ionov et al. (U.S. Patent 6,816,682 B1), Miyauchi et al. (U.S. Patent 6,823,141 B2), Lau et al. (K. Lau et al., "Ultra-High Speed Semiconductor Lasers", IEEE Journal of Quantum Electronics, Vol. QE-21, No. 2, February 1985) and Adachi et al. (U.S. Patent 6,974,068).

Regarding claims 1, 6 and 13, Paiella et al. discloses in FIG. 2 a transmitter comprising a mid-infrared laser (QC laser) for generating a stream of optical pulses according to a stream of input signal. As illustrated in FIG. 2, the QC laser is directly modulated to generate high and low optical power levels as illustrated in FIG. 3. The difference between Paiella et al. and the claimed invention is that Paiella et al. does not teach to use the transmitter to transmit pulses to a remote receiver for free space communication. Christopher teaches in FIG. 23 a free space communication system using 10-micro optical link. Christopher teaches in paragraph [0058] that mid-infrared wavelength is preferable over near-infrared for free-space communication because it has less attenuation over fog conditions. One of ordinary skill in the art would have been motivated to combine the teaching of Christopher with the mid-IR transmitter of Paiella et al.

and apply the mid-IR transmitter to transmit optical pulses over free space channel to a remote receiver because mid-IR pulses have less attenuation over fog conditions and the transmitter of Paiella et al. generates short pulses and supports high data-rate communication. Thus it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the mid-IR transmitter of Paiella et al. for free space communication, as taught by Christopher, because mid-IR pulses have less attenuation over fog conditions and the transmitter of Paiella et al. generates short pulses and supports high data-rate communication.

The modified free space communication system of Paiella et al. and Christopher still fails to teach receiving a stream of input data signals since Paiella et al. only uses FIG. 2 to demonstrate the operation theory. Ionov et al. discloses in FIG. 2 a real optical transmitter 48 that received input data signals form sorter 42. One of ordinary skill in the art would have been motivated to combine the teaching of Ionov et al. with the modified free space communication system of Paiella et al. and Christopher because a real system transmits data and generates revenue. Thus it would have been obvious to one of ordinary skill in the art at the time the invention was made to transmit real data signals received by the optical transmitter, as taught by Ionov et al., in the modified free space communication system of Paiella et al. and Christopher because a real system transmits data and generates revenue.

The modified free space communication system of Paiella et al., Christopher and Ionov et al. still fails to teach RZ-coded transmission. It is well known in the art that digital data can be transmitted using NRZ signal or RZ signal. For example, Miyauchi et al. teaches explains the in FIG. 3A and FIG. 3B NRZ and RZ signals. FIG. 3A shows that in RZ signal the duration of a non-lasing state representing 0 is longer that the lasing interval representing 1. One of ordinary

skill in the art would have been motivated to use RZ format for digital transmission because RZ-coded signal is lesser affected by the inter-symbol interference due to the increase of the width of pulses on the transmission line than the NRZ coded signal (see col. 5, lines 49-51 of Miyauchi et al.). Thus it would have been obvious to one of ordinary skill in the art at the time the invention was made to use RZ-coded signal for digital data transmission, as taught by Miyauchi et al., in the modified free space communication system of Paiella et al., Christopher and Ionov et al. because RZ-coded signal is lesser affected by the inter-symbol interference due to the increase of the width of pulses on the transmission line than the NRZ coded signal.

Paiella et al. teaches on page 781, right col., last paragraph that the QC laser is biased with a DC current of 200 mA, approximately 80% of its CW threshold value. Paiella et al. does not mention the bias voltage. However, voltage can be calculated by Ohm's law if the resistance of the laser is known. Lau et al. teaches semiconductor lasers and teaches in FIG. 13(b)·that a laser diode has an equivalent forward bias resistance of 2 f2. Adachi et al. teaches in FIG. 44 an equivalent circuit of a laser diode. Adachi et al. teaches in col. 26, lines 2-3 that resistor 902 is about 1 f2 in the case of an A1GaAs type semiconductor laser, which is the type of laser of Paiella et al. A simple calculation shows that the threshold current is 250 mA and the Paiella et al. teaches a DC bias of 50 mA from the lasing threshold. With a 2 Ω resistance, this is equivalent to 0.1 volt from the lasing threshold; with a 1 Ω resistor, this is equivalent to 0.05 volt from the lasing threshold.

Regarding claims 8 and 17-18, Christopher suggests a wavelength of 10 microns.

Regarding claims 10 and 19, both Christopher and Paiella et al. teach that mid-infrared light has low atmospheric losses (see p. 781, second paragraph of Paiella et al.).

Regarding claim 11-12, Paiella et al. teaches a QC laser which operates at around 3 GHz (see p. 781, right col., first paragraph).

Regarding claim 15, Paiella et al. teaches in FIG. 2 and FIG. 3 that the laser output is at a high optical power level when the laser is driven above a lasing threshold, and the laser output is at a low optical power level when the laser is below the lasing threshold. Paiella et al. teaches on page 781, right col., last paragraph that the laser is biased at approximately 80% of its CW threshold value.

Regarding claim 16, Paiella et al. teaches a quantum cascade laser.

3. Claims 2, 7 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Paiella et al. (R. Paiella et al., "Generation and Detection of High-Speed Pulses of Mid-Infrared Radiation with Intersubband Semiconductor Lasers and Detectors", IEEE Transactions on Photonics Technology Letters, Vol. 12, No. 7, July 2000) in view of Christopher (U.S. Patent Application Pub. 2002/0181059 A1), Lau et al. (K. Lau et al., "Ultra-High Speed Semiconductor Lasers", IEEE Journal of Quantum Electronics, Vol. QE-21, No. 2, February 1985) and Adachi et al. (U.S. Patent 6,974,068).

Regarding claim 2, Paiella et al. discloses in FIG. 2 a transmitter comprising a mid-infrared laser (QC laser) for generating a stream of optical pulses according to a stream of input signal. As illustrated in FIG. 2, the QC laser is directly modulated to generate high and low optical power levels as illustrated in FIG. 3. Paiella et al. teaches in FIG. 2 and FIG. 3 that the laser output is at a high optical power level when the laser is driven above a lasing threshold, and the laser output is at a low optical power level when the laser is below the lasing threshold. Paiella et al. teaches on page 781, right col., last paragraph that the laser is biased at

approximately 80% of its CW threshold value. The difference between Paiella et al. and the claimed invention is that Paiella et al. does not teach to use the transmitter to transmit pulses to a remote receiver for free space communication. Christopher teaches in FIG. 23 a free space communication system using 10-micro optical link. Christopher teaches in paragraph [0058] that mid-infrared wavelength is preferable over near-infrared for free-space communication because it has less attenuation over fog conditions. One of ordinary skill in the art would have been motivated to combine the teaching of Christopher with the mid-IR transmitter of Paiella et al. and apply the mid-IR transmitter to transmit optical pulses over free space channel to a remote receiver because mid-IR pulses have less attenuation over fog conditions and the transmitter of Paiella et al. generates short pulses and supports high data-rate communication. Thus it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the mid-IR transmitter of Paiella et al. for free space communication, as taught by Christopher, because mid-IR pulses have less attenuation over fog conditions and the transmitter of Paiella et al. generates short pulses and supports high data-rate communication.

The modified free space communication system of Paiella et al. and Christopher still fails to teach receiving a stream of input data signals since Paiella et al. only uses FIG. 2 to demonstrate the operation theory. Ionov et al. discloses in FIG. 2 a real optical transmitter 48 that received input data signals form sorter 42. One of ordinary skill in the art would have been motivated to combine the teaching of Ionov et al. with the modified free space communication system of Paiella et al. and Christopher because a real system transmits data and generates revenue. Thus it would have been obvious to one of ordinary skill in the art at the time the invention was made to transmit real data signals received by the optical transmitter, as taught by

Ionov et al., in the modified free space communication system of Paiella et al. and Christopher because a real system transmits data and generates revenue.

Paiella et al. teaches on page 781, right col., last paragraph that the QC laser is biased with a DC current of 200 mA, approximately 80% of its CW threshold value. Paiella et al. does not mention the bias voltage. However, voltage can be calculated by Ohm's law if the resistance of the laser is known. Lau et al. teaches semiconductor lasers and teaches in FIG. 13(b) that a laser diode has an equivalent forward bias resistance of 2 f2. Adachi et al. teaches in FIG. 44 an equivalent circuit of a laser diode. Adachi et al. teaches in col. 26, lines 2-3 that resistor 902 is about 1 f2 in the case of an A1GaAs type semiconductor laser, which is the type of laser of Paiella et al. A simple calculation shows that the threshold current is 250 mA and that Paiella et al. teaches a DC bias of 50 mA from the lasing threshold. With a 2 Ω resistance, this is equivalent to 0.1 volt from the lasing threshold; with a 1 Ω resistor, this is equivalent to 0.05 volt from the lasing threshold.

Regarding claims 7 and 9, Christopher suggests a wavelength of 10 microns.

4. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Paiella et al., Christopher, Ionov et al., Lau et al. and Adachi et al. as applied to claims 2, 7 and 9 above, and further in view of et al. (U.S. Patent 6,549,556 B1).

Paiella et al., Christopher, Ionov et al., Lau et al. and Adachi et al. have been discussed above in regard to claims 2, 7 and 9. The difference between Paiella et al., Christopher, Ionov et al., Lau et al. and Adachi et al. and the claimed invention is that Paiella et al., Christopher, Ionov et al., Lau et al. and Adachi et al. do not teach electrical pumping and optical pumping for laser operation. Hwang et al. teaches in col. 1, lines 50-65 operation of semiconductor lasers. A

semiconductor laser includes a gain region for building up energy. Various forms of pumping energy may be utilized to cause the active region to emit photons including electrical pumping, optical pumping and electron beam pumping. These are equivalent mechanisms for pumping energy to a semiconductor laser. Where the claimed differences involve the substitution of interchangeable or replaceable equivalents and the reason for the selection of one equivalent for another was not to solve an existent problem, such substitution has been judicially determined to have been obvious. See In re Ruff, 118, USPQ 343 (CCPA 1958). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use either electrical pumping or optical pumping to build up energy in the active region of a semiconductor laser in the modified free space communication system of Paiella et al., Christopher, Ionov et al., Lau et al. and Adachi et al.

5. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. as applied to claims 1, 6, 8, 10-13 and 15-19 above, and further in view of Durant et al. (U.S. Patent 6,016,212).

Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. have been discussed above in regard to claims 1, 6, 8, 10-13 and 15-19. The difference between Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. and the claimed invention is that the modified free space communication of Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. does not teach collimating optics. However, it is well known in the art to use optics to change the geometry of light beams. For example, Durant et al. teaches in FIG. 1 and col. 3, lines 5-10 to use collimating optics to form a light beam of a diameter of half an inch (13 mm). One of ordinary skill in the art would have

been motivated to combine the teaching of Durant et al. with the modified free space optical communication system of Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. because an appropriate light beam size makes it easy for alignment while maintains a reasonable size for the optics such as telescope. Thus it would have been obvious to one of ordinary skill in the art at the time the invention was made to use collimating optics to obtain an appropriate geometry for the light beam, as taught by Durant et al., in the modified free space optical communication system of Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. because an appropriate light beam size makes it easy for alignment while maintains a reasonable size for the optics such as telescope.

6. Claims 21-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. as applied to claims 1, 6, 8, 10-13 and 15-19 above, and further in view of Hwang et al. (U.S. Patent 6,549,556 B1).

Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. have been discussed above in regard to claims 1, 6, 8, 10-13 and 15-19. The difference between Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. and the claimed invention is that Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. do not teach electrical pumping and optical pumping for laser operation. Hwang et al. teaches in col. 1, lines 50-65 operation of semiconductor lasers. A semiconductor laser includes a gain region for building up energy. Various forms of pumping energy may be utilized to cause the active region to emit photons including electrical pumping, optical pumping and electron beam pumping. These are equivalent mechanisms for pumping energy to a semiconductor laser. Where the claimed differences involve the substitution of interchangeable

or replaceable equivalents and the reason for the selection of one equivalent for another was not to solve an existent problem, such substitution has been judicially determined to have been obvious. See In re Ruff, 118, USPQ 343 (CCPA 1958). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use either electrical pumping or optical pumping to build up energy in the active region of a semiconductor laser in the modified free space communication system of Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al.

7. Claims 14 and 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. as applied to claims 1, 6, 8, 10-13 and 15-19 above, and further in view of Ramaswami et al. ("Optical Networks: a Practical Perspective" by Ramaswami et al., Academic Press, 1998, pp. 177-180).

Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. have been discussed above in regard to claims 1, 6, 8, 10-13 and 15-19. The difference between Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al. and the claimed invention is that Paiella et al., Christopher, Ionov et al., Lau et al. and Adachi et al. do not teach percentage of lasing interval. Firstly, percentage of lasing interval depends on data rate. Secondly, Ramaswami et al. teaches in FIG. 4.1 short pulse format which minimize the effects of chromatic dispersion. One of ordinary skill in the art would have been motivated to use short pulse format for digital data transmission because it minimizes chromatic dispersion. Thus it would have been obvious to one of ordinary skill in the art at the time the invention was made to use short pulse format, as taught by Ramaswami et al., in the modified space communication system of Paiella et al., Christopher, Ionov et al., Miyauchi et al., Lau et al. and Adachi et al.

because it minimizes chromatic dispersion. Paiella et al. teaches in FIG. 3(a) that the pulse width is 89 psec. For a data rate of 1 GHz, the lasing interval is less than 10% of the data period.

Response to Arguments

8. Applicant's arguments filed 20 August 2007 have been fully considered but they are not persuasive.

The Applicant argues that the references do not teach DC biasing a pumping voltage for the mid-IR laser to be 0.001 volts to 0.1 volts from a lasing threshold. The amendment includes a declaration made by Professor Rainer Martini. In the declaration, Professor Martini gives a detailed interpretation of the papers by Paiella et al. and Gmachl et al. Professor Martini carefully calculates the voltage across the QC laser to be 5.98 volts and, using a linear interpolation, arrives at a bias voltage of 1.196 volts. While the linear interpolation may quickly gives an approximation of the bias voltage, such approximation may not be adequate. The Examiner cites two references for Professor Martini to review:

(a) Baillargeon et al. (U.S. Patent 6,463,088 B1), with common inventors of instant application and common authors of the papers by Paiella et al. and Gmachl et al.

(b) Capasso et al. (U.S. Patent 6,556,604 B1), with common inventors of instant application and common authors of the papers by Paiella et al. and Gmachl et al.

By comparing the contents of these patents with Paiella et al., the Examiner believes that the lasers of the patents are similar to the laser of Paiella et al. Baillargeon et al. teaches in FIG. 6 an I-V curve for a quantum cascade (QC) laser. The Examiner notices that the curve is nonlinear with a sudden change of resistance around the threshold. The Examiner approximates the I-V curve with two line segments: one below threshold and one above threshold. The line

segment that above threshold intersects the axis at 17.6 volt for current = 0A and at 18.8 volt for current = 1.25A. This gives a resistance of 0.96 Ω. Capasso et al. teaches in FIG. 8 an I-V curve for a QC laser. A similar approximation give 9.5 volts at current = 0A and 15.1 volts at current = 5A. This gives a resistance of 1.1 Ω. This affirms the resistance values used in the rejection.

In summary, Professor Martini provides a detailed explanation for supporting the argument that Paiella et al. is biased at 1.196 volts below lasing threshold. However, Professor Martini fails to recognize the nonlinearity of the I-V curve of a QC laser. Therefore, the conclusion drawn by Professor Martini may not hold.

Conclusion

9. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shi K. Li whose telephone number is 571 272-3031. The examiner can normally be reached on Monday-Friday (7:30 a.m. - 4:30 p.m.).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jason Chan can be reached on 571 272-3022. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

skl
9 November 2007

Shi K. Li
Primary Patent Examiner